U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.4 CONTROL ROOM HABITABILITY SYSTEM

REVIEW RESPONSIBILITIES

Primary - ~~Accident Evaluation Branch (AEB)~~Plant Systems Branch (SPLB)[1]

Secondary - ~~Effluent Treatment Systems Branch (ETSB)~~Emergency Preparedness and Radiation Protection Branch (PERB)[2]

- ~~Siting Analysis Branch (SAB)~~Materials and Chemical Engineering Branch (EMCB)[3]

I. AREAS OF REVIEW

The control room ventilation system and control building layout and structures, as described in the applicant's safety analysis report (SAR), are reviewed with the objective of ~~assuring~~ensuring[4] that plant operators are adequately protected against the effects of accidental releases of toxic and radioactive gases. A further objective is to ~~assure~~ensure that the control room can be maintained as the backup center from which technical support center personnel can safely operate in the case of an accident. ~~To assure that these objectives are accomplished the following items are reviewed:~~These objectives are accomplished by the following:[5]

1. The zone serviced by the control room emergency ventilation system is examined to ascertain that all critical areas requiring access in the event of an accident are included within the zone (control room, kitchen, sanitary facilities, etc.) and to ~~assure~~ensure that those areas not requiring access are generally excluded from the zone.

2. The capacity of the control room in terms of the number of people it can accommodate for an extended period of time is reviewed to confirm the adequacy of self-contained

breathing apparatus and to determine the length of time the control room can be isolated before CO_2 levels become excessive.

3. The control room ventilation system layout and functional design is reviewed to determine flow rates and filter efficiencies for input into the analyses of the buildup of radioactive or toxic gases inside the control room, assuming a design basis release. Basic deficiencies that might impair the effectiveness of the system are examined. In addition, the system operation and procedures are reviewed.

4. The physical location of the control room with respect to potential release points of hazardous airborne materials is reviewed. The layout of the control building is reviewed to ~~assure~~ensure that airborne materials will not enter the control room from corridors or ventilation ducts, etc.

5. Radiation shielding provided by structural concrete is analyzed to determine the effectiveness of shielding and structure surrounding the control room. The control building layouts are checked to see if radiation streaming through doors or other apertures or from equipment might be a problem.

6. Independent analyses are performed to determine the radiation doses and toxic gas concentrations. ~~Estimates of dispersion of airborne contamination are made in conjunction with the assigned meteorologist.~~[6]

Review Interfaces[7]

1. The SPLB performs the following reviews as part of its primary review responsibility under the Standard Review Plan (SRP) sections indicated:

   a. The emergency standby atmosphere filtration system and iodine removal efficiencies of the control room atmosphere filtration system, as part of its responsibility for SRP Section 6.5.1.

   b. The design of the control room ventilation system, as part of its responsibility for SRP Section 9.4.1.

   c. The storage and location of CO_2 or other firefighting materials, as part of its responsibility for SRP Section 9.5.1.[8]

2. The SPLB will coordinate evaluations performed by other branches that interface with the overall evaluation of the control room habitability system, as follows:[9]

   a. The Civil Engineering and Geosciences Branch (ECGB) will evaluate potential sources of hazardous gas as part of its primary review responsibility for SRP Section 2.2.1-2.2.2. The ECGB will provide SPLB with a description of the sources, source location, estimated hazardous gas concentrations near the control room building, and probability estimates for accidental releases related to transportation.[10]

b. The PERB reviews radiation shielding and exposures as part of its primary review responsibility for SRP Sections 12.1 through 12.5.[11]

c. The PERB determines radiation levels external to the control room from design basis accidents (DBAs) as part of its primary review responsibility for SRP Section 15.6.5, Appendix A.[12]

d. The PERB provides estimates related to the dispersion of airborne contamination as part of its primary review responsibility for SRP Sections 2.3.4 and 2.3.5.[13]

e. The Technical Specifications Branch (TSB) reviews technical specifications as part of its primary review responsibility for SRP Section 16.0.[14]

~~A secondary review is performed by the Effluent Treatment Systems Branch (ETSB) and the Siting Analysis Branch (SAB) and the results are used by AEB in its overall evaluation of the control room habitability. ETSB reviews the iodine removal efficiencies of the control room atmosphere filtration system. The efficiencies are transmitted to AEB for use in the analysis and are referenced in the SER. The evaluation of the potential hazardous gas sources is performed by the SAB under SRP Section 2.2. The SAB will provide AEB with a description of the sources. In those cases where the identified sources are found to have the potential for incapacitating people in the vicinity of the control room building, the SAB will provide AEB with source location, estimated hazardous gas concentrations near the control room building, and probability for the releases with respect to transportation accidents.~~

~~In addition, AEB will coordinate the evaluation with other branches that interface with the review of the control room habitable system as follows: the Auxiliary System Branch (ASB) reviews the design of the control room ventilation system as part of its primary review responsibility for SRP Section 9.4.1. The Radiological Assessment Branch (RAB) reviews radiation shielding and exposures as part of the primary review responsibility for SRP Sections 12.1 through 12.5. The review for technical specifications are coordinated and performed by the Licensing Guidance Branch (LGB) as part of the primary review responsibility for SRP Section 16.0. The acceptance criteria necessary for the review and their application are contained in the above referenced SRP section of the corresponding primary branch.~~[15]

For those areas of review identified above as part of reviews under other SRP sections, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP sections.[16]

II. ACCEPTANCE CRITERIA

The control room habitability system design is acceptable if the requirements of the following regulations are met:

~~a~~A[17]. General Design Criterion 4 (GDC 4),[18] "Environmental and ~~Missile Design Bases~~Dynamic Effects Design Bases,"[19] as it relates to accommodating the effects of and being compatible with postulated accidents, including the effects of the release of toxic gases.

~~b~~B. General Design Criterion 5 (GDC 5),[20] "Sharing of Structures, Systems and Components," as it relates to facilities which have a single control room for more than one nuclear power unit and with respect to ensuring that such sharing will not significantly impair the ability to perform safety functions including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining unit(s).

~~c~~C. General Design Criterion 19 (GDC 19),[21] "Control Room," as it relates to maintaining the control room in a safe, habitable condition under accident conditions by providing adequate protection against radiation and toxic gases.

The specific criteria necessary to meet the relevant requirements of General Design Criteria 4, 5, and 19 and to ~~assure~~ensure that the control room habitability requirements and positions of 10 CFR 50.34(f)(2)(xxviii) (for those applicants subject to 10 CFR 50.34(f)) and[22] Item III.D.3.4 of NUREG-0737 are met are as follows:

1. Control Room Emergency Zone

   The control room emergency zone should include the following:

   a. Instrumentation and controls necessary for a safe shutdown of the plant, i.e., the control room, including the critical document reference file;

   b. Computer room, if it is used as an integral part of the emergency response plan;

   c. Shift supervisor's office; and

   d. Operator washroom and the kitchen.

2. Ventilation System Criteria

   The ventilation system should include the following design features: ~~is reviewed by ASB under SRP Section 9.4.1, "Control Room Area Ventilation System." The AEB reviewer ascertains from the ASB if the following system performance and availability criteria are met:~~[23]

   a. Isolation ~~dampers -~~[24] dampers used to isolate the control zone from adjacent zones or the outside should be leaktight. This may be accomplished by using low leakage dampers or valves. The degree of leaktightness should be documented in the SAR.

   b. ~~Single failure - a~~A[25] single failure of an active component should not result in loss of the system's functional performance. All the components of the control room emergency filter train should be considered active components. See Appendix A to this SRP for criteria regarding valve or damper repair.

3. Pressurization Systems

Ventilation systems that will pressurize the control room during a radiation emergency should meet the following requirements:

a. Systems having pressurization rates of greater than or equal to 0.5 volume changes per hour should be subject to periodic verification (every 18 months) that the makeup is + 10% of design value. During plant construction or after any modification to the control room that might significantly affect its capability to maintain a positive pressure, measurements should be taken to verify that the control room is pressurized to at least 3.2-mm (1/8-in)[26] water gauge relative to all surrounding air spaces while applying makeup air at the design rate.

b. Systems having pressurization rates of less than 0.5 and equal to or greater than 0.25 volume changes per hour should have identical testing requirements as indicated in (1) above. In addition, at the CP, combined license (COL), or standard design certification[27] stage, an analysis should be provided (based on the planned leaktight design features) that ensures the feasibility of maintaining 3.2-mm (1/8-in)[28] water gauge differential with the design makeup airflow rate.

c. Systems having pressurization rates of less than 0.25 volume changes per hour should meet all the requirements for (2) above, except that periodic verification of control room pressurization (every 18 months) should be specified.

4. Emergency Standby Atmosphere Filtration System

~~The atmosphere filtration system is reviewed by ETSB under SRP Section 6.5.1. The ETSB will determine the credit for iodine~~Iodine removal for this system should be in accordance with the guidelines of Regulatory Guide 1.52~~ and will advise the AEB accordingly~~. Efficiencies for systems not covered by Regulatory Guide 1.52 will be determined on a case-by-case basis~~ by ETSB~~.[29] For new applications, the system should also conform with ASME Code AG-1, "Code on Nuclear Air and Gas Treatment" including the AG-1a-92 Addenda (Reference 14).[30] Protection of control room personnel from releases of chlorine or other toxic gases is addressed in Regulatory Guides 1.78 and 1.95 as discussed in the criteria below.[31]

5. Relative Location of Source and Control Room

The control room inlets should be located considering the potential release points of radioactive material and toxic gases. Specific criteria as to radiation and toxic gas sources are as follows:

a. Radiation sources. As a general rule the control room ventilation inlets should be separated from the major potential release points by at least 31 meters (100 feet)[32] laterally and by 16 meters (50 feet)[33] vertically. However, the actual minimum distances must be based on the dose analyses (Ref. 9).

b. Toxic gases. The minimum distance between the toxic gas source and the control room is dependent upon the amount and type of the gas in question, the container

size, and the available control room protection provisions. The acceptance criteria for the control room habitability system are provided in the regulatory positions of Regulatory Guide 1.78 with respect to postulated hazardous chemical releases in general and in Regulatory Guide 1.95 with respect to accidental chlorine releases in particular.

6. Radiation Hazards

The dose guidelines for evaluating the emergency zone radiation protection provisions are as follows:

whole body gamma:	50 mSv (5 rem)[34]
thyroid:	300 mSv (30 rem)[35]
beta skin dose:	300 mSv (30 rem)[36*37 38]

In accordance with GDC 19, these doses to an individual in the control room should not be exceeded for any postulated design basis accident. The whole body gamma dose consists of contributions from airborne radioactivity inside and outside the control room, as well as direct shine from all radiation sources.

7. Toxic Gas Hazards

Three exposure categories are defined: protective action exposure (2 minutes or less), short-term exposure (between 2 minutes and 1 hour), and long-term exposure (1 hour or greater). Because the physiological effects can vary widely from one toxic gas to another, the following general restrictions should be used as guidance: there should be no chronic effects from exposure; acute effects, if any, should be reversible within a short period of time (several minutes) without benefit of any measures other than the use of self-contained breathing apparatus.

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[*]Credit for the beta radiation shielding afforded by special protective clothing and eye protection is allowed if the applicant commits to their use during severe radiation releases. However, even though protective clothing is used, the calculated unprotected skin dose is not to exceed 750 mSv (75 rem).[37] The skin and thyroid dose levels are to be used only for judging the acceptability of the design provisions for protecting control room operators under postulated design basis accident conditions. They are not to be interpreted as accept able emergency doses. The dose levels quoted here are derived for use in the controlled plant environment and should not be confused with the conservative dose computation assumptions used in evaluating exposures to the general public for the purposes of comparison with the guideline values of 10 CFR Part 100.

The whole-body gamma, thyroid, and beta skin doses are consistent with the recommendations of International Committee on Radiation Protection (ICRP) 26, which were used in the May 21, 1991, revision of 10 CFR Part 20.

The allowable limits should be established on the basis that the operators should be capable of carrying out their duties with a minimum of interference caused by the gas and subsequent protective measures. The limits for the three categories normally are set as follows:

a. Protective action limit (2 minutes or less): Use a limit that will ~~assure~~ensure that the operators will quickly recover after breathing apparatus is in place. In determining this limit, it should be assumed that the concentration increases linearly with time from zero to two minutes and that the limit is attained at two minutes.

b. Short-term limit (2 minutes to 1 hour): Use a limit that will ~~assure~~ensure that the operators will not suffer incapacitating effects after a 1-hour exposure.

c. Long-term limit (1 hour or greater): Use a limit assigned for occupational exposure (40-hour week).

The protective action limit is used to determine the acceptability of emergency zone protection provisions during the time personnel are in the process of fitting themselves with self-contained breathing apparatus. The other limits are used to determine whether the concentrations with breathing apparatus in place are applicable. They are also used in those cases where the toxic levels are such that emergency zone isolation without use of protective gear is sufficient. Self-contained breathing apparatus for the control room personnel (at least 5 individuals) should be on hand. A 6-hour onsite bottled air supply should be available with unlimited offsite replenishment capability from nearby location(s). As an example of appropriate limits, the following are the three levels for chlorine gas:

protective action: 15 ppm by volume

short-term: 4 ppm by volume

long-term: 1 ppm by volume

Regulatory Guide 1.78 provides a partial list for protective action levels for other toxic gases.

Technical Rationale[39]

The technical rationale for application of these acceptance criteria is discussed in the following paragraphs:[40]

1. Compliance with GDC 4 requires that structures, systems, and components important to safety be designed to accommodate the effects of, and be compatible with, environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents (LOCAs). These structures, systems, and components shall be appropriately protected against dynamic effects (e.g., the effects of

missiles, pipe whipping, and discharging fluids) that may result from equipment failures or from events and conditions outside the nuclear power unit.

The function of the control room habitability system is to provide a suitable and controlled environment for the control room and equipment located therein during normal operation, anticipated operational occurrences, and during and after postulated accidents, including LOCAs. GDC 4 applies to this SRP section because the reviewer verifies that the control room will remain functional throughout the course of operating and accident events and that operators will be able to carry out their responsibilities without being subject to undue stress.

Meeting the requirements of GDC 4 provides assurance that the control room habitability system will function as designed, thereby providing protection to plant operators against the effects of accidental releases of toxic and radiological gases.[41]

2. Compliance with GDC 5 requires that structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown in the remaining units.

For a multiple-unit facility in which there is a common control room, components of the control room habitability system will necessarily be shared; whereas, for a multiple-unit facility in which there are separate control rooms, components of the control room habitability system need not be shared. For either design, it must be demonstrated that the operating environment of control areas for each unit remains within specified limits in the event of an accident or toxic gas release, thereby ensuring that control operators and essential equipment in the control room will be able to continue functioning effectively throughout the course of the event. In this manner, an event at one unit will be prevented from propagating to another unit.

Meeting the requirements of GDC 5 provides assurance that a failure in one unit of a multiple-unit site will not affect an orderly shutdown and cooldown in remaining units.[42]

3. Compliance with GDC 19 requires that the control room remain functional so that actions can be taken (a) to operate the nuclear power unit safely under normal conditions and (b) to maintain the plant in a safe state under accident conditions, including LOCAs.

GDC 19 applies to this SRP section because the reviewer verifies that adequate radiation protection and protection from hazardous chemical releases will be provided to permit access to and occupancy of the control room under accident conditions. Regulatory Guides 1.52, 1.78, and 1.95 present methods acceptable to the staff for meeting control room occupancy protection requirements.

Meeting the requirements of GDC 19 provides assurance that adequate protection will be maintained to permit access to and occupancy of the control room under accident conditions.[43]

4. Compliance with 10 CFR 50.34(f)(2)(xxviii) requires the evaluation of potential pathways for radioactive materials that may lead to problems related to control room habitability under accident conditions.

The requirements 10 CFR 50.34(f)(2)(xxviii) apply to this SRP section because the review evaluates issues involving isolation of the control room, pressurization to prevent inleakage, filtration of the control room air, and location of ventilation intakes. Collectively, these criteria are designed to mitigate the radiological consequences of accidents in the control room.

Meeting the requirements of 10 CFR 50.34(f)(2)(xxviii) provides assurance that, in the event of an accident, radiation doses to operators will not exceed acceptable limits and consequently prevent operators from performing required functions.[44]

III. REVIEW PROCEDURES

The reviewer selects and emphasizes aspects of the areas covered by this review plan as appropriate for a particular case. The judgment on areas to be given attention and emphasis in the review is based on an inspection of the material presented to see whether it is similar to that recently reviewed for other plants and whether items of special safety significance are involved.

1. Control Room Emergency Zone

The reviewer verifies that the control room emergency zone includes the areas identified in subsection II.1 of this SRP section. The emergency zone should be limited to those spaces requiring operator occupancy. Spaces such as battery rooms, cable spreading rooms, or other spaces not requiring continuous or frequent occupancy after a ~~design basis accident (~~DBA~~)~~[45] generally should be excluded from the emergency zone. Inclusion of these spaces may increase the probability of smoke or hazardous gases entering the emergency zone. They may also increase the possibility of infiltration into the emergency zone, thus decreasing the effectiveness of the ventilation system in excluding contamination. It is advantageous to have the emergency zone located on one floor, with the areas included in the zone being contiguous.

2. Control Room Personnel Capacity

A control room designed with complete isolation capability from the outside air to provide radiation and toxic gas protection is reviewed to determine if the buildup of carbon dioxide could present a problem. The air inside a 2830 m^3 (100,000 cubic foot,[46] control room would support five persons for at least six days. Thus, CO_2 buildup in an isolated emergency zone is not normally considered a limiting problem.

3. Ventilation System Layout and Functional Design

The reviewer evaluates the control room ventilation system in order to establish appropriate parameters to be used in the control room dose calculations. The ~~review is coordinated with the ASB which evaluates the~~ control room ventilation system design

and performance is evaluated[47] in accordance with SRP Section 9.4.1. The reviewer should use Regulatory Guide 1.52 and, for new applications, ASME Code AG-1 including the AG-1a-92 Addenda to evaluate the system.[48] The procedures are as follows:

a. The type of system proposed is determined. The following types of protection provisions are currently being employed for boiling water reactor (BWR) or pressurized water reactor (PWR) plants:

(1) Zone isolation, with the incoming air filtered and a positive pressure maintained by the ventilation system fans. This arrangement is often provided for BWRs having high stacks. Airflow rates are between 190 and 1900 L/s (400 and 4000 cfm).[49]

(2) Zone isolation, with filtered recirculated air. This arrangement is often provided for BWRs and PWRs with roof vents. Recirculation rates range from 950 to 14,200 L/s (2000 to 30,000 cfm).[50]

(3) Zone isolation, with filtered recirculated air, and with a positive pressure maintained in the zone. This arrangement is essentially the same as that in (2), with the addition of the positive pressure provision.

(4) Dual air inlets for the emergency zone. In this arrangement two widely spaced inlets are located outboard, on opposite sides of potential toxic and radioactive gas sources. The arrangement guarantees at least one inlet being free of contamination, except under extreme no-wind conditions. It can be used in all types of plants. Makeup air supplied from the contamination-free inlet provides a positive pressure in the emergency zone and thus minimizes infiltration.

(5) Bottled air supply for a limited time. In this arrangement a flow rate of 190 to 290 L/s (400 to 600 cfm)[51] is provided from compressed air containers for about 1 hour to prevent inleakage. It is used in systems having containments whose internal atmospheric pressure becomes negative within an hour after a DBA (subatmospheric containments).

b. The input parameters to the radiological dose model are determined (see Item 5 below). The parameters are emergency zone volume, filter efficiency, filtered makeup airflow rate, unfiltered inleakage (infiltration), and filtered recirculated airflow rate.

c. The ventilation system components and the system layout diagrams are examined. ~~The review will be coordinated with the ASB in particular if there are questions pertaining to the system design. ASB~~The reviewer[52] will determine if the system meets the single failure criterion as well as other safety requirements under SRP Section 9.4.1. Damper failure and fan failure are especially important. The review should confirm that the failure of isolation dampers on the upstream side

of fans will not result in too much unfiltered air entering the control room. The radiation dose and toxic gas analysis results are used to determine how much unfiltered air can be tolerated.

d. The following information may be used in evaluating the specific system types (see Ref. 6 for further discussion):

(1) Zone isolation with filtered incoming air and positive pressure. These systems may not be sufficiently effective in protecting against iodine. The staff allows an iodine protection factor (IPF), which is defined as the time-integrated concentration of iodine outside over the time-integrated concentration within the emergency zone, of 20 to 100 for filters built, maintained, and operated according to Regulatory Guide 1.52. An IPF of 100 requires deep bed filters. Such systems are likely to provide a sufficient reduction in iodine concentration only if the source is at some distance from the inlets. Thus, in most cases only plants with high stacks (about 100 meters) would meet GDC 19 with this system.

(2) Zone isolation with filtered recirculated air. These systems have a greater potential for controlling iodine than those having once-through filters. IPFs ranging from 20 to over 150 can be achieved. These are the usual designs for plants having vents located at containment roof level. A system having a recirculation rate of 2400 L/s (5000 cfm)[53] and a filter efficiency of 95% would be rated as follows:

Infiltration L/s (cfm)[54]	IPF[**]
100 (200)[55]	25
50 (100)[56]	49
24 (50)[57]	96
12 (25)[58]	191

Infiltration should be determined conservatively. The calculated or measured gross leakage is used to determine the infiltration rate that will be applied in the evaluation of the radiological consequences of postulated accidents. This rate is determined as follows:

(i) the leakage from the control room when pressurized to 3.2-mm (1/8-in)[59] water gauge is calculated on the basis of the gross leakage data. One-half of this value is used to represent the base infiltration rate. Component leak rates may be used to calculate gross leakage (see, for example, Refs. 10 and 11).

[**]Within the range of interest, the iodine protection factor is directly proportional to recirculation flow rate times efficiency.

(ii) The base infiltration rate is augmented by adding to it the estimated contribution from opening and closing of doors associated with such activities as required by the plant emergency plans and procedures. Normally, 5 L/s (10 cfm)[60] is used for this additional contribution.

(iii) An additional factor that is used to modify the base infiltration rate is the enhancement of the infiltration occurring at the dampers or valves upstream of recirculation fans. When closed, these dampers typically are exposed to a pressure differential of several millimeters (inches)[61] water gauge. This is accounted for by an additional infiltration contribution over the base infiltration of 3.2-mm (1/8-in)[62] water gauge.

The use of an infiltration rate that is based on calculation is acceptable except in the case where the applicant has assumed exceptionally low rates of infiltration. In these cases, more substantial verification or proof may be required. For instance, if an applicant submits an analysis that shows a gross leakage rate of less than 0.06 volume changes per hour, the reviewer would require that the gross leakage be verified by periodic tests as described in Regulatory Position C.5 of Regulatory Guide 1.95.

(3) Zone isolation with filtered recirculated air and a positive pressure. This system is essentially the same as the preceding one. However, an additional operational mode is possible. Makeup air for pressurization is admitted. It is filtered before entering the emergency zone. Pressurization reduces the unfiltered inleakage that is assumed to occur when the emergency zone is not pressurized. Assuming a filter fan capacity of 2400 L/s (5000 cfm)[63] and a filter efficiency of 95%, the following protection factors result (flows in L/s (cfm)[64]):

Makeup Air	Recirculated Air	IPF (Assuming No Infiltration)	IPF (Assuming Infiltration[***65])
190 (400)[66]	2200 (4600)[67]	238	159
350 (750)[68]	2000 (4250)[69]	128	101
470 (1000)[70]	1900 (4000)[71]	96	80

The makeup flow rate should have adequate margin to ~~assure~~ensure that the control room will be maintained at a pressure of at least 3.2-mm (1/8-in)[72] water gauge. The applicant should indicate that an acceptance

[***]Normally 5 L/s (10 cfm) infiltration is assumed for conservatism. This flow could be reduced or eliminated if the applicant provides assurance that backflow (primarily as a result of ingress and egress) will not occur. This may mean installing two-door vestibules or equivalent.

test will be performed to verify adequate pressurization. If the makeup rate is less than 0.5 volume changes per hour, supporting calculations are required to verify adequate airflow. If the makeup rate is less than 0.25 volume changes per hour, periodic verification testing is required in addition to the calculations and the acceptance test.

A question that often arises is whether "pressurization" or "isolation and recirculation" of the control room is to be preferred. Which design gives the lowest doses depends upon the assumptions as to unfiltered inleakage. Isolation limits the entrance of noble gases (not filterable) and, in addition, it is a better approach when the accident involves a short-term "puff release." If infiltration is 12 L/s (25 cfm)[73] or less, "isolation" would be best in any event.

A second question related to the first involves the method of operation. The following possibilities have been considered:

(i) automatic isolation with subsequent manual control of pressurization.

(ii) automatic isolation with immediate automatic pressurization.

The first is advantageous in the case of external puff releases. Simple isolation would maintain the buildup of the unfilterable noble gases. It would also protect the filters from excessive concentrations in the case of a chlorine release. However, the second method does guarantee that infiltration (unfiltered) is reduced to near zero immediately upon accident detection. This would be beneficial in the case where the contamination transport path to the emergency zone is mainly inside the building. Method (i) should be used in the case of a toxic gas release and either method (i) or (ii) should be used in the case of a radiological release, provided GDC 19 can be satisfied.

A substantial time delay should be assumed where manual isolation is assumed, e.g., 20 minutes for the purposes of dose calculations.

(4) Dual air inlets for the emergency zone. Several plants have utilized this concept. The viability of the dual inlet concept depends upon whether or not the placement of the inlets ~~assures~~ensures that one inlet will always be free from contamination. The assurance of a contamination free inlet depends in part upon building wake effects, terrain, and the possibility of wind stagnation or reversal. For example, in a situation where the inlets are located at the extreme edges of the plant structures (e.g., one on the north side and one on the south side), it is possible under certain low probability conditions for both inlets to be contaminated from the same point source. Reference 9 presents the position for dealing with the

evaluation of the atmospheric dispersion (X/Q values) for dual inlet systems.

With dual inlets placed on plant structures on opposite sides of potential radiation release points (e.g., containment building) and capable of functioning with an assumed single active failure in the inlet isolation system, the following considerations may be applied to the evaluation of the control room X/Q's:

(i) Dual inlet designs without manual or automatic selection control - equation (6) of Reference 9 may be used with respect to the least favorable inlet location to estimate X/Q's. The estimated values can be reduced by a factor of 2 to account for dilution effects associated with a dual inlet configuration. This is based upon the dilution derived from drawing in equal amounts of clean and contaminated air through two open inlets.

(ii) Dual inlet designs with manual selection control - equation (6) of Reference 9 may be used with respect to the more favorable inlet location to estimate the X/Q's. The estimated values can be reduced by a factor of 4 to account for dilution effects associated with a dual inlet configuration and the relative probability that the operator will make the proper inlet selection. The reduction factor is contingent upon having redundant radiation detectors within each air inlet. The reduction factor is based on the judgment that trained control room operators, in conjunction with radiation alarm indication, will select and close the contaminated air inlet.

(iii) Dual inlet designs with automatic selection control features - equation (6) of Reference 9 may be used with respect to the more favorable inlet location to estimate the X/Q's. The estimated values can be reduced by about a factor of 10 to account for the ability to select a "clean" air inlet. The actual factor may be somewhat higher if the inlet configuration begins to approach the remote air inlet concept such that the probability of having one clean air inlet is relatively high. Plant configuration and meteorological conditions should be used as the principal basis for reduction factors greater than 10. The reduction factor of 10 or more is contingent upon having redundant detectors in each inlet and the provisions of acceptable control logic which would be used in the automatic selection of a clean air inlet.

Because damage to the ducting might seriously affect the system capability to protect the operators, the ducting should be seismic Category I and should be protected against tornado missiles. In addition, the number and placement of dampers must be such as to ~~assure~~ensure both flow and isolation in each inlet assuming one single active

component-failure (see Appendix A for information on the damper repair alternative). The location of the intakes with respect to the plant security fence should also be reviewed. Evaluation of the design options described above depends on the physical characteristics of the site as well as the plant design and, thus, can be finalized only at the COL stage of review.[74]

(5) Bottled air supply for a limited time. In some plant designs the containment pressure is reduced below atmospheric within 1 hour after a DBA. This generally ~~assures~~ensures that after 1 hour significant radioactive material will not be released from the containment. Such a design makes it feasible to maintain the control room above atmospheric pressure by use of bottled air. Periodic pressurization tests are required to determine that the rated flow, normally about 150 to 300 L/s (300 to 600 cfm),[75] is sufficient to pressurize the control room to at least 3.2-mm (1/8-in)[76] water gauge. The system is also required to be composed of several separate circuits, one of which is assumed to be inoperative to account for a possible single failure. At least one nonredundant, once through filter system for pressurization as a standby for accidents of long duration should be provided.

Compressed air bottles should be protected from tornado missiles or internally generated missiles and should be placed so as not to cause damage to vital equipment or interference with operation if they fail.

4. Atmosphere Filtration Systems

~~ETSB~~SPLB[77] evaluates the iodine removal efficiency of the atmosphere filtration systems under SRP Section 6.5.1 and determines the appropriate credit to be given ~~and advises the AEB reviewer~~.[78] The SPLB review should also include evaluation of the testing proposed for the filtration system and should use applicable positions of Regulatory Guide 1.52 for guidance.[79]

5. Relative Location of Source and Control Room

The ~~SAB~~ECGB[80] will identify all potential sources of toxic or otherwise potentially hazardous gases as described in SRP Section ~~2.2~~2.2.1-2.2.2.[81] The ~~SAB~~ECGB[82] will provide to the ~~AEB~~SPLB[83] the findings of its toxic gas estimates for use in the control room habitability analysis. There are three basic categories: Radioactive sources, toxic gases such as chlorine, and gases with the potential for being released inside confined areas adjacent to the control room. Evaluation of the relative locations of sources and airborne transport of toxic or otherwise potentially hazardous gases depends on the physical and meteorological characteristics of the site, and plant design and, thus, can be finalized only at the COL stage of review.[84]

a. Radiation Sources

The LOCA source terms determined from the ~~AEB~~PERB[85] review in accordance with ~~Appendix A to~~ SRP Section 15.6.5, Appendix A,[86] are routinely used to evaluate radiation levels external to the control room. The dispersal from the containment or the standby gas treatment vent is determined with a building wake diffusion model. This model is discussed in Reference 9. Contamination pathways internal to the plant are examined to determine their impact on control room habitability. Other DBAs are reviewed to determine whether they might constitute a more severe hazard than the LOCA. If appropriate, an additional analysis is performed for the suspect DBAs.

b. Toxic Gases

The ~~SAB~~ECGB[87] will review and identify those toxic substances stored or transported in the vicinity of the site which may pose a threat to the plant operators upon a postulated accidental release. The method used to determine whether the quantity or location of the toxic material is such as to require closer study is described in Regulatory Guide 1.78. This guide also discusses the methods for analyzing the degree of risk and states, in general terms, the various protective measures that could be instituted if the hazard is found to be too great. In the case of chlorine, specific acceptable protective provisions ~~have been determined (Ref. 8)~~are provided in Regulatory Guide 1.95.[88]

In summary, the following provisions or their equivalent are required for the emergency zone ventilation system:

(1) quick-acting toxic gas detectors,

(2) automatic emergency zone isolation,

(3) emergency zone leaktightness,

(4) limited fresh air makeup rates, and

(5) breathing apparatus and associated bottled air supply.

The best solution for a particular case will depend on the toxic gas in question and on the specific ventilation system design.

c. Confined Area Releases

The reviewer studies the control building layout in relation to potential sources of radiation and toxic gases inside the control building or adjacent connected buildings. The following is considered:

(1) Storage location of ~~C0(2)~~CO_2 or other firefighting materials should be such as to eliminate the possibility of significant quantities of the gases

entering the emergency zone. The review will be coordinated with the ~~Chemical Engineering Branch (CMEB)~~EMCB.[89]

(2) The ventilation zones adjacent to the emergency zone should be configured and balanced to preclude airflow toward the emergency zone.

(3) All pressurized equipment and piping (e.g., main steam lines and turbines) that could cause significant pressure gradients when failed inside buildings should be isolated from the emergency zone by multiple barriers such as multiple door vestibules or their equivalent.

6. Radiation Shielding

Control room operators as well as other plant personnel are protected from radiation sources associated with normal plant operation by a combination of shielding and distance. The adequacy of this type of protection for normal operating conditions is coordinated with the ~~RAB~~ PERB.[90] To a large extent the same radiation shielding (and missile barriers) also provides protection from DBA radiation sources. This is especially true with respect to the control room walls which usually consist of at least 46 cm (18 in)[91] of concrete. In most cases, the radiation from external DBA radiation sources is attenuated to negligible levels. However, the following items should be considered qualitatively in assessing the adequacy of control room radiation shielding and should be coordinated with the ~~RAB~~PERB[92] who will be requested to provide assistance as necessary.

a. Control Room Structure Boundary

Wall, ceiling, and floor materials and thickness should be reviewed. Forty-six to 61 centimeters (Eighteen inches to 2 feet)[93] of concrete or its equivalent will be adequate in most cases.

b. Radiation Streaming

The control room structure boundary should be reviewed with respect to penetrations (e.g., doors, ducts, stairways). The potential for radiation streaming from accident sources should be identified, and if deemed necessary, quantitatively evaluated.

c. Radiation Shielding from Internal Sources

If sources internal to the control room complex are identified, protective measures against them should be reviewed. Typical sources in this category include contaminated filter trains, or airborne radioactivity in enclosures adjacent to the control room. Evaluations of radiation shielding effectiveness with respect to the above items should be performed using simplified analytical models for point, line, or volume sources such as those presented in References 12 and 13. If more extended analysis is required, analytical support from the ~~RAB~~PERB[94] should be

requested. The applicant's coverage of the above items should also be reviewed in terms of completeness, method of analysis, and assumptions.

7. Independent Analyses

The applicant is required to calculate doses to the control room operators. Independent analyses are made by the ~~AEB~~PERB[95] because of the diversity of control room habitability system designs and the engineering judgment involved in their evaluation. Since this analysis involves site-related characteristics, it can be finalized only at the COL stage of review.[96] Using the approach indicated in Reference 9, the source terms and doses due to a DBA are calculated. The source terms determined by the ~~AEB~~PERB[97] independent analysis of low population zone (LPZ) doses for a LOCA are used. The methods and assumptions for this calculation are presented in ~~Appendix A to~~ SRP Section 15.6.5, Appendix A.[98] The control room doses are determined by estimating the X/Q from the source points to the emergency zone using meteorological input supplied by the assigned meteorologist, by determining the credit for the emergency zone's protection features, and by calculating the dose. The attached Table 6.4-1 is a form which may be used to summarize the information that is needed for the control room dose calculation. The effective X/Q's are used for calculating the doses. The dose is then compared with the guidelines of GDC 19. If the guideline values are exceeded, the applicant will be requested to improve the system. In the event that other DBAs are expected to result in doses comparable to or higher than the LOCA, additional analyses are performed. The limiting consequences of the accidents are compared with GDC 19.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.[99]

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the review and calculations support conclusions of the following type, to be included in the staff's safety evaluation report (SER)[100] (note: items 2 and 3 should be included only if appropriate):

We conclude that the control room habitability system of the (insert PLANT NAME) facility is acceptable and meets the requirements of the following General Design Criteria:

1. GDC 19, "Control Room," with respect to maintaining the control room in a safe and habitable condition under accident conditions by providing adequate protection against radiation and toxic gases such that the radiological exposures are within the limits of this criterion, and

2. GDC 4, "Environmental and ~~Missile Design Bases~~Dynamic Effects Design Bases,"[101] with respect to the environmental effects of the release of toxic gases and

3. GDC 5, "Sharing of Structures, Systems, and Components," with respect to ensuring that the control room, shared by Units ___ and ___ of the (insert PLANT NAME) facility will not significantly impair the ability of the control room personnel to perform safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the other unit(s)."

These conclusions are based on the staff review and evaluation that the control room habitability systems meet the regulatory positions of Regulatory Guide 1.52, "Design Testing and Maintenance Criteria for Engineered-Safety-Feature Atmospheric Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," and Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Release."

In meeting the positions of these regulatory guides, the applicant has demonstrated that the control room will adequately protect the control room operators and will remain habitable in accordance with Task Action Plan Item III.D.3.4 of NUREG-0737 and 10 CFR 50.34(f)(2)(xxviii) (for those applicants subject to 10 CFR 50.34(f)).[102]

~~If the design is not adequate, the fact is stated. Alternatives such as an increase in the charcoal filter flow rate may be indicated as is given in the example below:~~

~~The staff has calculated the potential radiation doses to control room personnel following a LOCA. The resultant whole body doses are within the guidelines of General Design Criterion 19. The thyroid dose resulting from exposure to radioactive iodine exceeds the dose guidelines. A method of meeting GDC 19 would be to increase the filtration system size from 2,000 to 4000 cfm. This increased filtration will be sufficient to keep the estimated thyroid doses within the guidelines.~~[103]

If special protection provisions for toxic gases are not required, the following statement or its equivalent is made:

The habitability of the control room was evaluated using the procedures described in Regulatory Guide 1.78. As indicated in Section ~~2.2~~2.2.1-2.2.2,[104] no offsite storage or transport of chemicals is close enough to the plant to be considered a hazard. There are no onsite chemicals that can be considered hazardous under Regulatory Guide 1.78. A sodium hypochlorite biocide system will be used, thus eliminating an onsite chlorine hazard. Therefore, special provisions for protection against toxic gases will not be required. In accordance with plant emergency plans and procedures, self-contained breathing apparatus is provided for assurance of control room habitability in the event of occurrences such as smoke hazards.

If special protection provisions are required for toxic gases, compliance or noncompliance with the guidelines of Regulatory Guides 1.78 and 1.95 should be stated. Since toxic gas risk is related to site characteristics, this part of the evaluation will be completed at the COL stage of review.[105]

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.[106]

V. IMPLEMENTATION

The following provides guidance to applicants and licensees regarding the staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.[107] Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.[108]

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

1. 10 CFR Part 50 Appendix A, General Design Criterion 4, "Environmental and ~~Missiles Design Bases~~Dynamic Effects Design Bases."[109]

2. 10 CfR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems and Components."

3. 10 CFR Part 50, Appendix A, General Design Criterion 19, "Control Room."

4. 10 CFR 50.34(f), "Additional TMI-Related Requirements."[110]

5. NUREG-0737, "Clarification of TMI Action Plan Requirements," Item III.D.3.4, "Control Room Habitability," November 1980.

6. Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

7. Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release."

8. Regulatory Guide 1.95, "Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release."

9. K. G. Murphy and K. M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19," 13th AEC Air Cleaning Conference, August 1974.

10. "Leakage Characteristics of Openings for Reactor Housing Components," NM-SR-MEMO-5137, Atomics International, Div. of North American Aviation, Inc., June 20, 1960.

11. R. L. Koontz, et al., "Leakage Characteristics of Conventional Building Components for Reactor Housing Construction," Trans. Am. Nucl. Soc., November 1961.

12. R. G. Jaeger, et al., eds., "Engineering Compendium on Radiation Shielding," Vol. 1, "Shielding Fundamentals and Methods," Springer Verlag (1968).

13. N. M. Schaeffer, "Reactor Shielding for Nuclear Engineers," TID-75951, U.S. Atomic Energy Commission.

14. ASME Code AG-1, "Code for Nuclear Air and Gas Treatment," 1991 (including the AG-1a-92 Addenda thereto).[111]

SECTION 6.4 APPENDIX A

ACCEPTANCE CRITERIA FOR VALVE OR DAMPER REPAIR ALTERNATIVE

The control room ventilation system must meet the criterion to function properly, even with a single failure of an active component. In certain cases, complex valve or damper configurations are required to meet the single failure criterion. For example, assurance of the isolation and operability of each leg of a dual inlet system at various times after a postulated accident could require a four-valve arrangement in which two pairs of series valves are connected in parallel. The mechanical, power, and control components of such arrangements combine to form a rather complex system. Credit will be allowed for an alternative system that allowed the failed valve to be manually repositioned so that it will not interfere with the operation of the system. For example, in the case of a dual inlet system, if credit for repair is given, then two valves in series in each leg of the dual inlet would be acceptable. Where a valve fails closed but meets the criteria given below, credit would be allowed for the valve to be repositioned and locked in an open position.

The approval of the repair option is contingent upon the intrinsic reliability of the internal components of the valve or damper and also upon the ease and ability to overcome the failure of the external actuating components (electrical relays, motors, hydraulic pistons, etc.). The following criteria or their equivalent will be required.

1. The valve or damper components must be listed as to which are considered internal (nonrepairable) and which external (repairable). These must be designed to meet the following criteria.

    a. Internal valve components (i.e., components that are difficult to repair manually without opening the ductwork) must be judged to have a very low probability of failure. The component design details will be reviewed and characteristics such as simplicity, ruggedness, and susceptibility to postulated failure mechanisms will be considered in arriving at an engineered judgment of the acceptability of the internal component design with respect to reliability. For example, a butterfly valve welded or keyed onto a pivot shaft would be considered a high reliability internal component. Conversely, multiple blade dampers, actuated by multi-element linkages or pneumatically operated components internal to the ducts, would be viewed as being subject to failure.

    b. External valve components (i.e., components including motors and power supplies that are to be assumed repairable or removable) must be designed to ensure that the failed valve component can be bypassed easily and safely and that the valve can be manipulated into an acceptable position. The electronic components must be isolated from other equipment to ~~assure~~ensure that the repair operations do not result in further equipment failure.

2. The location and positioning of the valve or damper must permit easy access from the control room for convenient repair, especially under applicable DBA conditions.

3. Appropriate control room instrumentation should be provided for a clear indication and annunciation of valve or damper malfunction.

4. Periodic manipulation of the valve or damper by control room operators should be required for training purposes and to verify proper manual operability of the valve or damper.

5. The need for manual manipulations of the failed valve or damper should not be recurrent during the course of the accident. Manipulation should not occur more than once during the accident. Adjustment or realignment of other parts of the system should be possible from the control room with the failed valve in a fixed position.

6. The time for repair used in the computation of control room exposures should be taken as the time necessary to repair the valve plus a one-half hour margin. No manual correction will be credited during the first two hours of the accident.

7. Compliance with the above criteria should be documented in the SAR whenever the repair option is used.

TABLE 6.4-1 Summary Sheet for Control Room Dose Analysis

~~MEMORANDUM TO: _____ , AEB Lead Reviewer~~
~~_____, Meteorologist~~

~~cc: Meteorology Section, AEB~~
~~AEB Habitability Files~~

~~CONCERNING CONTROL ROOM DOSE ANALYSIS FOR (Insert Plant Name)~~[112]

The following summarizes the X/Q's used in determining the control room operator dose for evaluation of the subject plant at the COL stage of review:[113]

A. VENTILATION SYSTEM DESCRIPTION

B. SKETCH OF SYSTEM (and inlets/sources if applicable)

C. SUMMATION OF X/Q ANALYSIS

Source/Receptor Type and Distance
S/D Ratio K Factor

Number of 22-1/2° Wind Direction
Sectors that Result in Exposure

Central Wind Sector (sector wind is blowing from)

5% Wind Speed (m/sec) 40% Wind Speed (m/sec)

Projected Area of Wake (m^2) 5% X/Q (sec/m^3)

Time	Wind Speed Factor	Wind Direction Factor	Occupancy Factor	Effective X/Q's
0-8 hr	1	1	1	
8-24 hr			1	
1-4 day			0.6	

4-30 day	0.4	

TABLE 6.4-1 Summary Sheet for Control Room Dose Analysis-continued

D. ACTION REQUESTED

Assigned Reviewer

- For your information only

- Please use the effective X/Q's in TACT run and provide control room doses. In addition, please summarize safety system assumptions and indicate their status (interim or final).

Meteorologist

- These are interim X/Q's. Please review to determine their reasonableness.

- These are final X/Q's. Please determine if they are accurate based on your analysis of site data.

Please Contact [114]

SRP Draft Section 6.4
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Changed PRB to Plant Systems Branch (SPLB).
2.	Current SRB name and abbreviation	Changed SRB to Emergency Preparedness and Radiation Protection Branch (PERB).
3.	Current SRB name and abbreviation	Changed SRB to Materials and Chemical Engineering Branch (EMCB).
4.	Editorial	Changed assure to ensure. (Global change for this SRP section.)
5.	Editorial	Revised for clarity and readability.
6.	SRP-UDP format item	Moved review responsibility for meteorology to "Review Interfaces."
7.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW and organized in numbered paragraph form to describe how other SRP sections interface with SRP Section 6.4 and how other branches support the SPLB review.
8.	SRP-UDP format item	Identified SRP Sections 6.5.1, 9.4.1, and 9.5.1, which interface with SRP Section 6.4 as an SPLB responsibility.
9.	SRP-UDP format item	Prepared lead-in sentence on SPLB coordination with other review branches and organized in numbered paragraph form.
10.	SRP-UDP format item	Changed review branch responsibility for potential hazardous gas sources to ECGB and revised description of branch responsibilities for clarity.
11.	SRP-UDP format item	Changed review branch responsibility for radiation shielding and exposures to PERB.
12.	SRP-UDP format item	Added review responsibilities for radiation levels external to the control room under SRP Section 15.6.5, Appendix A, to PERB.
13.	SRP-UDP format item	Added review responsibility for dispersion of airborne contamination to PERB.
14.	Current review branch name and abbreviation	Changed review branch to TSB and revised description of branch responsibility for clarity.
15.	SRP-UDP format item	Paragraphs removed to reflect current SRP numbered paragraph format and to redesignate the review branch responsibility for SRP Sections 2.2.1-2.2.2; 6.5.1; 9.4.1; 9.5.1; 12.1 through 12.5; 15.6.5, Appendix A; and 16.0.

Item	Source	Description
16.	SRP-UDP format item	Added standard text regarding acceptance criteria and methods of application of areas of review in other SRP sections.
17.	Editorial	Renumbered/lettered to reflect more commonly used outline numbering scheme.
18.	Editorial	Introduced "GDC 4" as initialism for "General Design Criterion 4."
19.	Editorial	Corrected title of GDC 4.
20.	Editorial	Introduced "GDC 5" as initialism for "General Design Criterion 5."
21.	Editorial	Introduced "GDC 19" as initialism for "General Design Criterion 19."
22.	**Integrated Impact 1007**, SRP-UDP format item	Added reference to 10 CFR 50.34(f)(2)(xxviii) and its characterization as a requirement for affected applicants.
23.	Editorial	Revised lead-in sentence because original specifies areas of review.
24.	Editorial	Deleted redundant words.
25.	Editorial	Deleted redundant words.
26.	Conversion to SI units	Added SI units for 1/8-in water guage.
27.	Integrated Impact No. 321	Added reference to COL and standard design certification.
28.	Conversion to SI units	Added metric units for 1/8-in water guage.
29.	Editorial	Revised lead-in sentence because original specifies areas of review.
30.	Integrated Impact No. 320	Added reference to industry standards in ACCEPTANCE CRITERIA.
31.	Editorial	Added reference to Regulatory Guides 1.78 and 1.95 for completeness since both are relevant to the emergency standby atmosphere filtration system.
32.	Conversion to SI units	Added metric units for 100 feet.
33.	Conversion to SI units	Added metric units for 50 feet.
34.	Conversion to SI units	Added SI units for 5 rem.
35.	Conversion to SI units	Added SI units for 30 rem.
36.	Conversion to SI units	Added SI units for 30 rem.
37.	Conversion to SI Units	Added SI units for 75 rem.

Item	Source	Description
38.	SRP-UDP format item	Added reference in the footnote to the May 21, 1991, revision of 10 CFR Part 20 to indicate that the recommended doses are consistent with that version of 10 CFR Part 20.
39.	SRP-UDP format item	Added "Technical Rationale" to ACCEPTANCE CRITERIA to describe the basis for referencing the acceptance criteria.
40.	SRP-UDP format item	Added lead-in statement for "Technical Rationale."
41.	SRP-UDP format item	Added technical rationale for GDC 4.
42.	SRP-UDP format item	Added technical rationale for GDC 5.
43.	SRP-UDP format item	Added technical rationale for GDC 19.
44.	SRP-UDP format item	Added technical rationale for 10 CFR 50.34(f)(2)(xxviii).
45.	Editorial	Used "DBA" as previously defined.
46.	Conversion to SI units	Added metric units for 100,000 cubic feet.
47.	SRP-UDP format item	Changed to reflect PRB responsibility for SRP Section 9.4.1.
48.	Integrated Impact No. 320	Added reference to guidance and an industry standard to REVIEW PROCEDURES.
49.	Conversion to SI units	Added metric units for 400 cfm and 4000 cfm.
50.	Conversion to SI units	Added metric units for 2000 cfm and 30,000 cfm.
51.	Conversion to SI units	Added metric units for 400 cfm and 600 cfm.
52.	SRP-UDP format item	Changed to reflect PRB responsibility for SRP Section 9.4.1.
53.	Conversion to SI units	Added SI units for 5000 cfm.
54.	Conversion to SI units	Added L/s.
55.	Conversion to SI units	Added metric units for 200 cfm.
56.	Conversion to SI units	Added metric units for 100 cfm.
57.	Conversion to SI units	Added metric units for 50 cfm.
58.	Conversion to SI units	Added metric units for 25 cfm.
59.	Conversion to SI units	Added metric units for 1/8-in water guage.
60.	Conversion to SI units	Added metric units for 10 cfm.
61.	Conversion to SI units	Added millimeters of water gauge.
62.	Conversion to SI units	Added metric units for 1/8-in water guage.
63.	Conversion to SI units	Added metric units for 5000 cfm.

Item	Source	Description
64.	Conversion to SI units	Added cfm.
65.	Conversion to SI units	Added metric units for 10 cfm.
66.	Conversion to SI units	Added metric units for 400 cfm.
67.	Conversion to SI units	Added metric units for 4600 cfm.
68.	Conversion to SI units	Added metric units for 750 cfm.
69.	Conversion to SI units	Added metric units for 4250 cfm.
70.	Conversion to SI units	Added metric units for 1000 cfm.
71.	Conversion to SI units	Added metric units for 4000 cfm.
72.	Conversion to SI units	Added metric units for 1/8-in water guage.
73.	Conversion to SI units	Added metric units for 25 cfm.
74.	Integrated Impact No. 321	Added reference to COL review for site-specific characteristics.
75.	Conversion to SI units	Added metric units for 300 cfm to 600 cfm.
76.	Conversion to SI units	Added metric units for 1/8-in water guage.
77.	Current PRB abbreviation	Changed PRB to SPLB.
78.	SRP-UDP format item	Changed to correct PRB responsibility.
79.	Editorial	Added reference to guidance applicable to filtration system testing to REVIEW PROCEDURES for consistency with subsection II.4.
80.	Current SRB abbreviation	Changed SRB to ECGB.
81.	Editorial	Corrected designation of SRP Section 2.2.
82.	Current SRB abbreviation	Changed SRB to ECGB.
83.	Current PRB abbreviation	Changed PRB to SPLB.
84.	Integrated Impact No. 321	Added reference to COL review for site-specific characteristics.
85.	Current SRB abbreviation	Changed SRB to PERB.
86.	Editorial	Standardized designation of SRP Section 15.6.5, Appendix A.
87.	Current SRB abbreviation	Changed SRB to ECGB.
88.	Editorial	Made specific reference to Regulatory Guide 1.95.
89.	Current review branch abbreviation	Deleted review branch name and changed abbreviation to EMCB.
90.	Current SRB abbreviation	Changed SRB to PERB.

Item	Source	Description
91.	Conversion to SI units	Added metric units for 18 inches.
92.	Current SRB abbreviation	Changed SRB to PERB.
93.	Conversion to SI units	Added metric units for 18 inches and 24 inches.
94.	Current SRB abbreviation	Changed SRB to PERB.
95.	Current SRB abbreviation	Changed SRB to PERB.
96.	Integrated Impact No. 321	Added reference to COL review for site-specific characteristics.
97.	Current SRB abbreviation	Changed SRB to PERB.
98.	Editorial	Standardized designation of SRP Section 15.6.5, Appendix A.
99.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
100.	Editorial	Provided "SER" as initialism for "safety evaluation report."
101.	Editorial	Corrected title of GDC 4.
102.	**Integrated Impact 1007**, SRP-UDP format item	Added reference to 10 CFR 50.34(f)(2)(xxviii).
103.	Editorial	Deleted paragraph because it is not appropriate for the staff to specify means of meeting GDC requirements.
104.	Editorial	Corrected designation of SRP Section 2.2.
105.	Integrated Impact No. 321	Added reference to COL review for site-specific characteristics.
106.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items relevant to the SRP section.
107.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
108.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
109.	Editorial	Corrected title of GDC 4.
110.	**Integrated Impact 1007**, SRP-UDP format item	Added 10 CFR 50.34(f) to references.

Item	Source	Description
111.	**Integrated Impact 320**, SRP-UDP format item	Since citation of this standard was added in subsections II and III, listing of it as a reference was also added in accordance with SRP-UDP format guidance.
112.	Editorial	Deleted memorandum heading because it is not an integral part of Table 6.4-1.
113.	Integrated Impact No. 321	Added reference to COL review for site-specific characteristics.
114.	Editorial	Deleted ACTION REQUESTED because it is not an integral part of Table 6.4-1.

Integrated Impact No.	Issue	SRP Subsections Affected
320	Revise specific criteria and Review Procedures to cite the ASME Code AG-1 for review of control room habitability system compliance with TMI Action Plan Item III.D.3.4, 10 CFR 50.34(f)(2)(xxviii), and GDC 19.	Section II, ACCEPTANCE CRITERIA, subsection number 4 Section III, REVIEW PROCEDURES, first paragraph, subsection number 3 Section VI, REFERENCES, item 14
321	Revise ACCEPTANCE CRITERIA, REVIEW PROCEDURES, and EVALUATION FINDINGS to reflect the DC/COL licensing process in reviews of control room habitability features related to toxic substance detection and protection, based upon the above information.	Section II, ACCEPTANCE CRITERIA, second paragraph, subsection 3.b Section III, REVIEW PROCEDURES, first paragraph, subsection 3.d(4) Section III, REVIEW PROCEDURES, first paragraph, subsection 5 Section III, REVIEW PROCEDURES, first paragraph, subsection 7 Section IV, EVALUATION FINDINGS, second paragraph, second subparagraph TABLE 6.4-1, first paragraph
322	Revise AREAS OF REVIEW and EVALUATION FINDINGS to address additional control room habitability hazards.	No changes were made in SRP 6.4 in response to Integrated Impact 322.
723	Consider future work to revise RG 1.95 to incorporate the results of the side-by-side comparison for IEEE Std 279/603.	No changes were made in SRP 6.4 in response to Integrated Impact 723.
1007	Add citation of 10 CFR 50.34(f)(2)(xxviii) in connection with the existing citation of TMI Item III.D.3.4. See Integrated Impact 320 for impact of TMI Item III.D.3.4.	Section II, ACCEPTANCE CRITERIA, second paragraph introduction to specific criteria Section IV, EVALUATION FINDINGS, third paragraph Section VI, REFERENCES, item 4